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Enhancing Atrial Flutter and Fibrillation Classification in ECG Signals: A PCA-Enabled Approach

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Abstract: *Electrocardiogram (ECG) patterns are crucial for diagnosing various heart diseases, including serious conditions like Atrial Flutter (AFL) and Atrial Fibrillation (AFib). Significant variations in the QRS complex are observed in abnormal ECG patterns, making the R wave crucial for assessing heart rate variability (HRV) and identifying abnormal cardiac rhythms. This research aims to classify AFL and AFib ECG patterns using machine learning-based tree classifiers and statistical features. The main contribution is the use of Principal Component Analysis (PCA) for the classification problem. Temporal features such as HRV, RR interval, and SDNN are extracted from the ECG database using the Pan Tomkins algorithm for QRS peak detection. The proposed method combines tree-based classifiers with PCA, achieving a high accuracy of 94.4% in distinguishing between AFL and AFib. The significance of this research lies in its potential to improve the accuracy, efficiency, and accessibility of ECG pattern classification, which could have far-reaching implications for cardiac care and early detection of serious heart conditions. The simplicity and accuracy of the classifiers suggest that the method could be implemented with lower computational requirements, potentially extending battery life in portable devices and reducing costs. Future research could explore larger ECG databases, multi-class classification, and other classifiers like SVM and KNN for further improvement in accuracy.*

Keywords: ECG, HRV, Atrial Flutter, Atrial Fibrillation, QRS Complex, Principle Component Analysis, SDNN, Tree Classifiers, Accuracy

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